ULTRASONIC WELDING PROCESS AND EQUIPMENT FOR CONSTRUCTION OF ELECTRON-TUBE MOUNTS

Sixth Quarterly Progress Report
For the Period
October 1 through December 31, 1963

Contract No. DA-36-039-sc86741
Order No. 19063-PP-62-81-81

Placed by
Industrial Preparedness Directorate
United States Army Electronics
Materiel Agency

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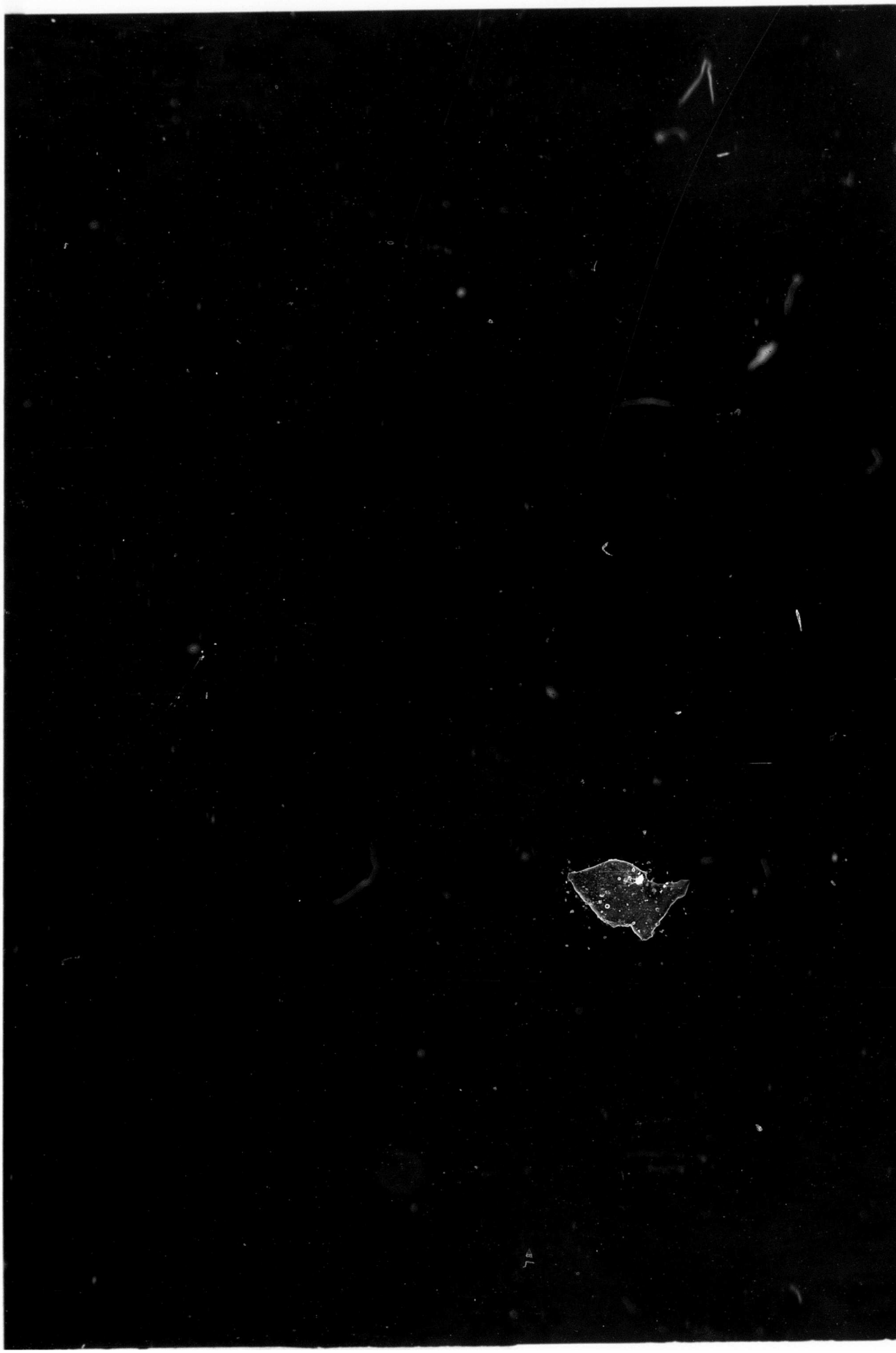

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Sixth Quarterly Progress Report
For the Period
October 1 through December 31, 1963

The object of this program is to design and construct prototype welding equipments and their associated accessories to perform by ultrasonic techniques the welding operations required in the assembly of electron tubes under Specifications SCS-114A and SCIPPR-15.

Contract No. DA-36-039-sc86741
Order No. 19063-PP-62-81-81

Report Prepared by: M. Rosenberg

Report Approved by: Byron Jones

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ABSTRACT

Successful ultrasonic welding of the 72-weld Type 6080WB electron-tube mount with production tooling was achieved.

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PURPOSES

The objectives of this Production Engineering Measure (PEM) are to:

1. Demonstrate the capability limits of ultrasonic welding to join combinations of metallic materials of interest to the electron-tube industry. This part of the work will be limited in that it will not continue exhaustive attempts to weld those combinations which might prove particularly difficult to join.

2. Analyze the welding requirements for three specific electron tubes. The three tube types selected are the Type 6080WB, 5814WB and 6205. These were selected by the U. S. Army Electronics Materiel Agency because they are widely used in military equipment, and have a record of failures due to improperly welded joints.

3. Prepare fixturing and tooling for the specific electron tubes, so that ultrasonic welding may be used in the manufacturing process.

4. Weld the parts required to assemble electron-tube mounts for the three tube types, and evaluate.

5. Build production ultrasonic welding equipment which will enable an electron-tube manufacturer to make the welded connections in a broad range of electron-tube types.

6. Install the ultrasonic welding equipment in a production company, and produce on a pilot basis with that company's personnel, a limited lot size of each of the three tubes for subsequent evaluation in accordance with applicable military specifications.

NARRATIVE AND DATA

ELECTRON-TUBE STUDY

1. Tooling

The tooling designed and fabricated during the last report period was based upon previously developed welding and assembly sequences (Third Quarterly Progress Report). In implementing the various fixtures, minor modifications in assembly sequence (Table I) and in the tooling enabled improved results. Combinations of tools in place for welding are shown in Figures 1 through 5.

The anvil tips were designed to bolt in various positions to a common copper block, which was bolted in turn to a steel base plate that could be mounted in any one of several locations on the welding head anvil support. This arrangement facilitated both alignment between the combinations of sonotrode and anvil tips and clearance for the components being welded. Typical of modifications to anvil tips, for component clearance purposes, were the relief area ground into the rear side of anvil tip A1 (Figure 1) and the small reduction in width of the projection on anvil tip A2 (Figure 2). These alterations in no way affected or changed basic tooling design concepts or welding procedures.

One anvil tip (A3 in Figures 3 and 5) was designed to do the work previously performed by two tips. This tip was mounted on the copper block through two slotted bolt holes, and its lateral movement permitted the welding of two sets of junctions.

Sonotrode tip T4 and anvil tip A4 (Figure 4) were tested in welding of connector material and stem lead wire. The anvil tip width was reduced from 11/16-inch to 9/16-inch, in order to overcome tip resonance at the welding frequency which produced only marginally satisfactory welds.

2. Welding

The tooling was used in producing the ultrasonically welded Type 6080WB electron-tube mount shown in Figure 6. Two stages of sub-assembly are shown in Figure 7. All components to be welded (Table II) were taken from the present Type 6080WB mount production line and were ultrasonically welded in the "as is" condition, as required for proper electron-tube manufacture, without additional cleaning or preparation. All welding was accomplished on the "Sonoweld" ultrasonic welder Model W-600-TSR. Settings of power, clamping force, and weld pulse time have been recorded for each junction to assist in start-up of electron-tube production.

In connection with welding of connectors and stem leads in glass stem assemblies, the glass fractured between the lead feed-through sections because of ultrasonic energy stresses transmitted through the stem lead. Many components involving glass have been ultrasonically welded without encountering this problem. It is possible that the physical condition of this particular glass (composition and temper) contributed to fracture, and the matter will be investigated during the next reporting period. Preventive measures such as damping and mass loading being impractical in this case, it was found that putting crimps in the stem leads with specially made pliers (Figure 8) solved the problem by the formation of sharp discontinuities which reduced the transmission of ultrasonic energy along the lead. Quality welds were then made on a reproducible basis without glass fracture, and the crimps did not alter spacing between stem leads or appear to introduce other factors which might affect tube performance.

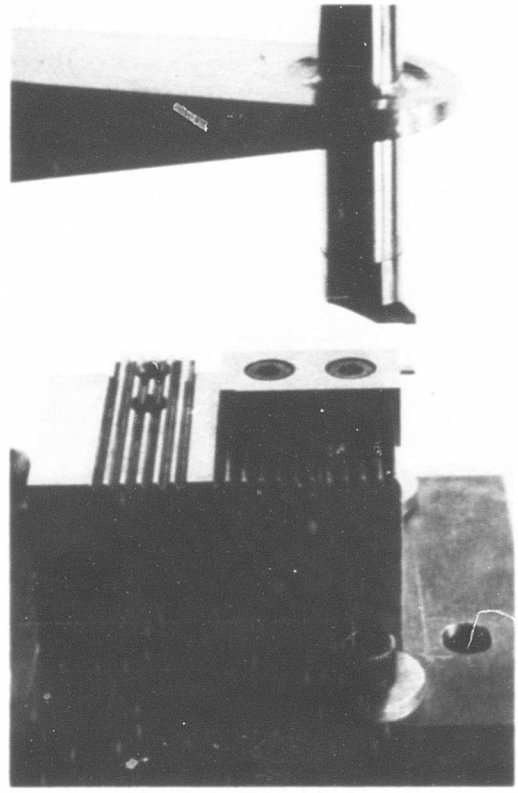
Experience gained during the program was reviewed as requested by USAEMA, with the result that specific suggestions were submitted concerning possible work scope modifications, for demonstrating even more dramatically the successful application of ultrasonic welding to the manufacture of electron-tube mounts.

CONCLUSIONS

Successful ultrasonic welding of the 72-weld Type 6080WB electron-tube mount has demonstrated the suitability of the equipment and process for fabricating complex assemblies.

PROGRAM FOR NEXT REPORTING PERIOD

Engineering representatives of Chatham Electronics will review the welding of the Type 6080WB electron-tube mount at Aeroprojects, in order to establish the suitability of all assembly and welding details for manufacturing production quantities of this mount. Investigation will be made into whether the physical condition of the glass in stem assemblies contributed to the glass fracturing during welding of connectors and stem leads.



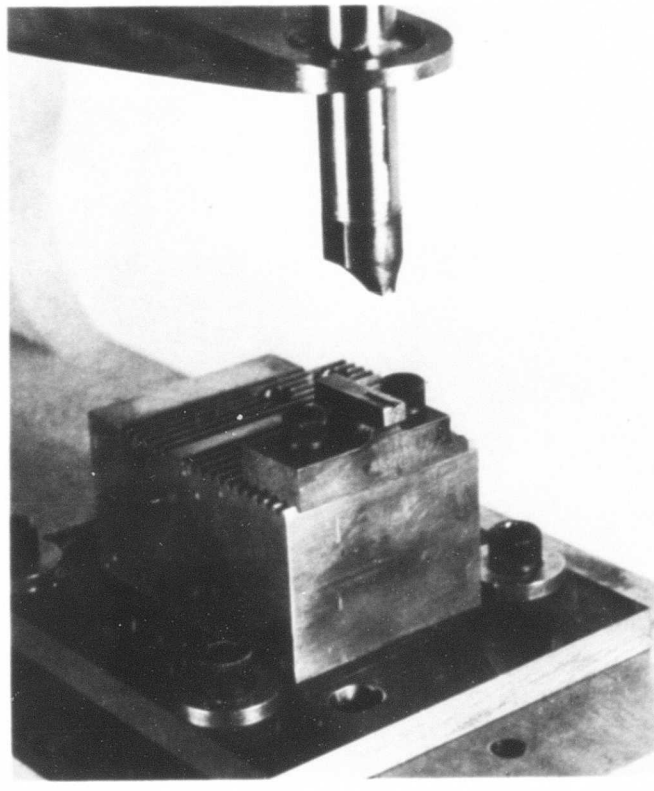
Sonotrode Tip
Number T1

Anvil Tip
Number A1

Figure 1

TYPE 6080WB ELECTRON-TUBE MOUNT TOOLING

Assembly Sequence No. 1, Cathode tab to cathode sleeve
No. 2, Cathode tab to itself



Sonotrode Tip
Number T2 or T3*

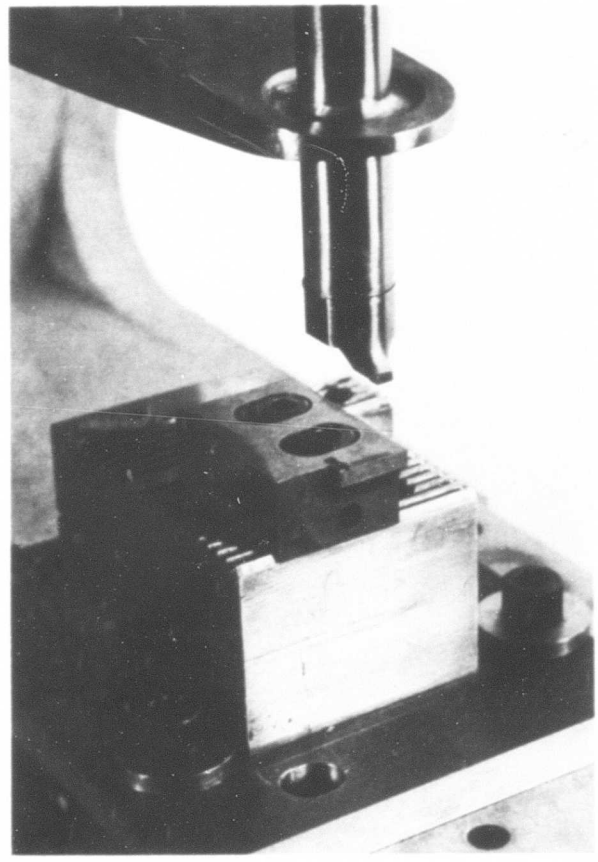
Anvil Tip
Number A2

Figure 2

TYPE 6080WB ELECTRON-TUBE MOUNT TOOLING

Assembly Sequence No. 3, Anode eyelet to anode support
No. 4, Grid eyelet to grid
No. 5, Anode connector to anode support
No. 6, Anode connector to anode support
No. 9, Grid connector to grid
No. 10, Grid connector to grid

* Tips T2 and T3 have the same shape, but different size grooves for welding different diameter wires. Tip T2 has a 0.037-inch radius groove. Tip T3 has a 0.020-inch radius groove.



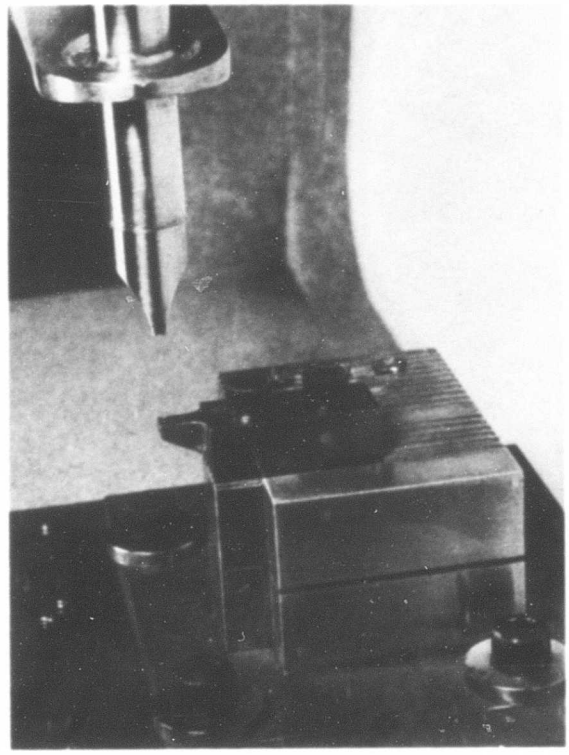
Sonotrode Tip
Number T1

Anvil Tip
Number A3
Position 1

Figure 3

TYPE 6080WB ELECTRON-TUBE MOUNT TOOLING

Assembly Sequence No. 7, Heater to heater connector, heater sleeve
No. 21, Cathode tabs to top cathode connectors



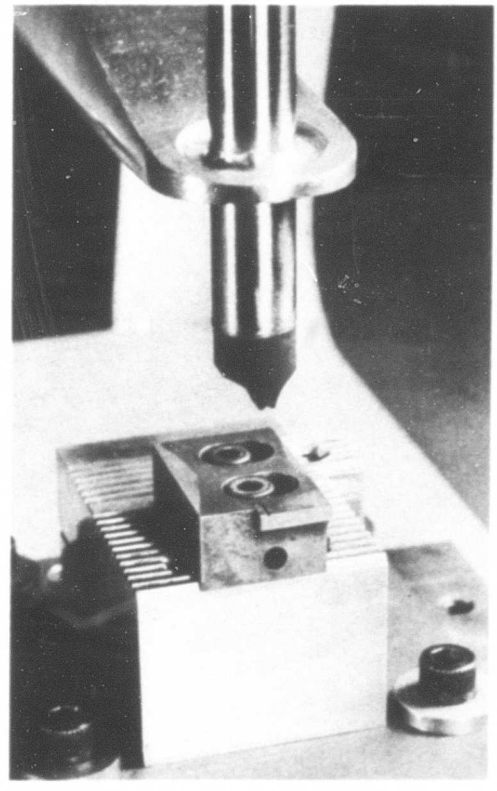
Sonotrode Tip
Number T4

Anvil Tip
Number A4

Figure 4

TYPE 6080WB ELECTRON-TUBE MOUNT TOOLING

Assembly Sequence No. 11, Stem lead to grid connectors (pins 1 & 4)
No. 12, Stem lead to anode connectors (pins 2 & 5)
No. 13, Stem lead to heater connectors (pins 7 & 8)
No. 14, Cathode connector to stem lead (pin 3)
No. 15, Cathode connector to stem lead (pin 6)
No. 16, Snubber supports to cathode connector
No. 17, Snubber supports to cathode connector



Sonotrode Tip
Number T3

Anvil Tip
Number A3
Position 2

Figure 5

TYPE 6080WB ELECTRON-TUBE MOUNT TOOLING

Assembly Sequence No. 19, Splash Spacer supports to snubber supports
No. 20, Top cathode connectors to snubber supports

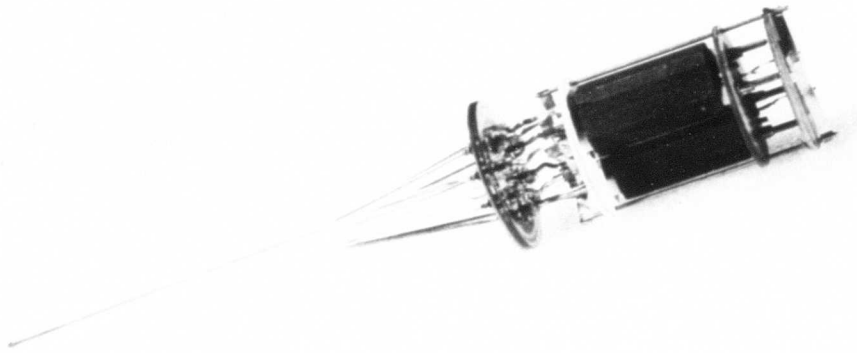


Figure 6

ULTRASONICALLY WELDED TYPE 6080WB
ELECTRON-TUBE MOUNT

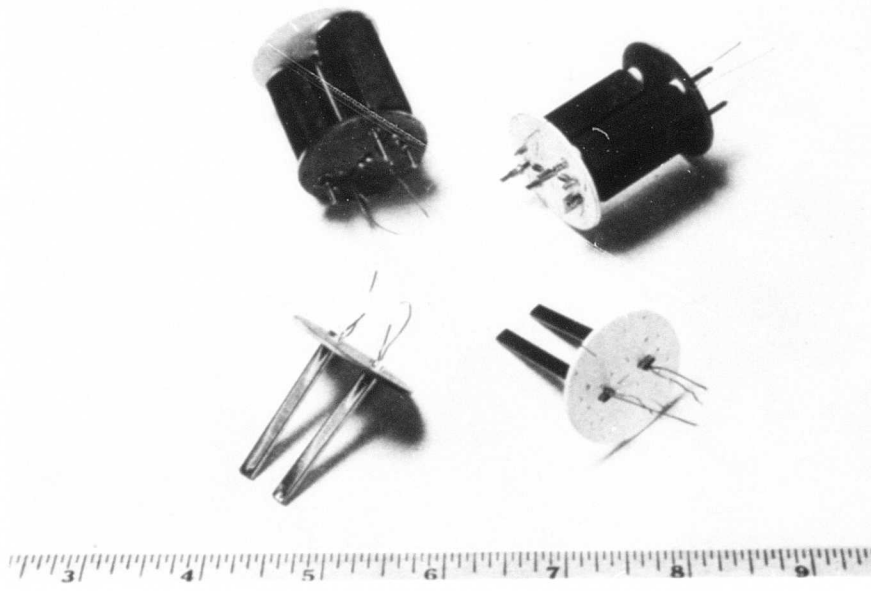


Figure 7

ULTRASONICALLY WELDED SUB-ASSEMBLIES
TYPE 6080WB ELECTRON-TUBE MOUNT

Foreground - Cathode, cathode tabs and splash spacer sub-assemblies

Background - Anode, splash spacers, and grid sub-assemblies prior to attachment of stem leads and top splash spacer

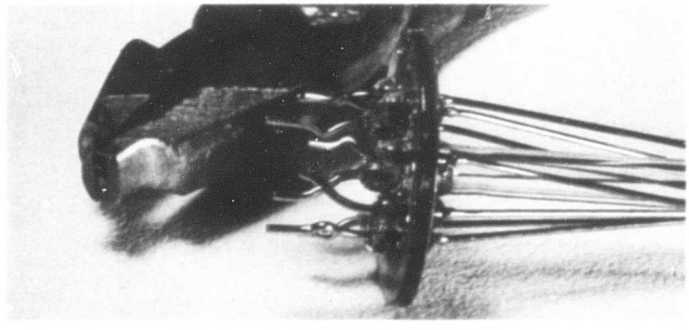


Figure 8

STEM LEAD CRIMPING

Table I

ASSEMBLY SEQUENCE AND WELD JUNCTURES
FOR TYPE 6080WB ELECTRON-TUBE MOUNT
(All welds made with 600-watt welder)

Assembly Sequence Number	Key Numbers*	Tip Number	Anvil Number	Figure Number	Description
1	1	T1	A1	1	Cathode tab to cathode sleeve
	(Mechanically assembled operation)				Assemble 2 cathode sleeve assemblies to top spacer
2	2	T1	A1	1	Cathode tab to itself.
	(Mechanically assembled operation)				Assemble with in-process clamp, 2 grid assemblies, 2 anode support assemblies, spacer-cathode assembly, 8 lava spacers and bottom spacer
3	7	T2	A2	2	Anode eyelet to anode support
4	6	T3	A2	2	Grid eyelet to grid
5	5	T2	A2	2	Anode connector to anode support
6	11	T2	A2	2	Anode connector to anode support
	(Mechanically assembled operation)				Assemble one heater connector
7	9	T1	A3 Pos. 1	3	Heater to heater connector, heater sleeve
8	10				Grid radiator to grid **
9	3	T3	A2	2	Grid connector to grid
10	4	T3	A2	2	Grid connector to grid
11	12b	T4	A4	4	Stem lead to grid connectors (pins 1 and 4)
12	12c	T4	A4	4	Stem lead to anode connectors (pins 2 and 5
13	12a	T4	A4	4	Stem lead to heater connectors (pins 7and8)
14	13a	T4	A4	4	Cathode connector to stem lead (pin 3)
15	14a	T4	A4	4	Cathode connector to stem lead (pin 6)
16	13b	T4	A4	4	Snubber supports to cathode connector
17	14b	T4	A4	4	Snubber supports to cathode connector
18	15				Snubber to snubber supports ***
	(Mechanically assembled operation)				Assemble splash spacer-cathode connector assembly with splash spacer supports
19	18	T3	A3 Pos. 2	5	Splash-spacer supports to snubber supports
20	16a	T3	A3 Pos. 2	5	Top cathode connectors to snubber supports
21	16b	T1	A3 Pos. 1	3	Cathode tabs to top cathode connectors
22	17				Getters to snubber supports ****

Corresponds to key numbers of Table II.
*Inaccessible for ultrasonic welding.

*** Unsuccessful
****Unsuccessful - Crossed-wire weld

Table II

DESCRIPTION OF WELDING JUNCTURES
TYPE 6080WB ELECTRON-TUBE MOUNT

Nos.	Component	to Component	Gage (inch)	Material	to Gage (inch)	Material	No. of Welds
1	Cathode tab	Cathode sleeve	0.005 x 0.020	"A" Nickel	0.0025	Inco 220 Nickel	2
2	Cathode tab	Itself	0.005 x 0.020	"A" Nickel	0.005 x 0.020	"A" Nickel	2
3	Grid connector	Grid	0.005	"A" Nickel	0.050 Dia	Soft Chrome Copper	1
4	Grid connector	Grid	0.005	"A" Nickel	0.050 Dia	Soft Chrome Copper	1
5	Anode connector	Anode support	0.005	"A" Nickel	0.062 Dia	1/2H "D" Nickel	1
6	Grid eyelet	Grid	0.005-0.008	Nickel	0.050 Dia	Soft Chrome Copper	2
7	Anode eyelet	Anode support	0.005-0.008	Nickel	0.062 Dia	1/2H "D" Nickel	6
8	Heater sleeve	Heater	0.0025 wall	Seamless tubing, "A" Nickel	0.00385 Dia	Tungsten	8
9	Heater sleeve	Heater connector	Flattened tubing	"A" Nickel	0.007	"A" Nickel or Nickel plated steel	8
10	Grid radiator	Grid	0.005	Carbonized Nickel-Duocarb	0.050 Dia	Soft Chrome Copper	4
11	Anode connector	Anode support	0.005	"A" Nickel	0.062 Dia	1/2H "D" Nickel	1
12 a	Stem leads	Heater connector	0.040 or 0.050 Dia	Nickel lead	0.007	"A" Nickel, nickel-plated steel	2
b	Stem leads	Grid connectors	0.040 or 0.050 Dia	Nickel lead	0.005	"A" Nickel	
c	Stem leads	Anode connectors	0.040 or 0.050 Dia	Nickel lead	0.005	"A" Nickel	

(Concluded on Next Page)

Table II (Concluded)

DESCRIPTION OF WELDING JUNCTURES
TYPE 6080WB ELECTRON-TUBE MOUNT

Key Nos.	Component	to Component	Gage (inch)	Material	to Gage (inch)	Material	No. of Welds
13 a	Cathode connector	Stem lead	0.005	"A" Nickel	0.040 or 0.050 Dia	Nickel lead	1
b	Cathode connector	Snubber support	0.005	"A" Nickel	0.040 Dia	1/2H "D" Nickel	1
14 a	Cathode connector	Stem lead	0.005	"A" Nickel	0.040 or 0.050 Dia	Nickel lead	1
b	Cathode connector	Snubber support	0.005	"A" Nickel	0.040 Dia	1/2H "D" Nickel	1
15	Snubber	Snubber support	0.008	Inconel-Hard Temper	0.040 Dia	1/2H "D" Nickel	16
16 a	Top Cathode connector	Snubber support	0.005	"A" Nickel	0.040 Dia	1/2H "D" Nickel	2
b	Top Cathode connector	Cathode tab	0.005	"A" Nickel	0.005 x 0.020	"A" Nickel	2
17	Getter	Snubber support	0.035 Dia	"D" Nickel	0.040 Dia	1/2H "D" Nickel	2
18	Splash spacer support	Snubber support	0.005	"A" Nickel	0.040 Dia	1/2H "D" Nickel	4
						Total Number of Welds	72

VISITS DURING THIS REPORT PERIOD

Date	Visit	Purpose of Visit
10-9-63	Mr. W. N. Rosenberg visited Messrs. B. F. Steiger and N. Helmstetter, Chatham Electronics, Livingston, New Jersey	Review welding of electron tubes, with particular reference to production tooling and assembly sequence.
11-7-63	Mr. W. N. Rosenberg visited Mr. H. Shienbloom, U. S. Army Electronics Materiel Agency, 225 S. Eighteenth Street, Philadelphia, Pennsylvania	Review program progress and scope.
11-15-63	Mr. W. N. Rosenberg visited Messrs. B. F. Steiger and N. Helmstetter, Chatham Electronics, Livingston, New Jersey	Review welding of electron tubes, with special attention given to refinements developed in tooling and sequencing techniques, to shock and vibration fixturing and procedures preparatory to Chatham performing stipulated tests, and to various suggested changes in program scope to be offerred to USAEMA.

TECHNICAL MAN-HOURS

EXPENDED DURING THIS REPORT PERIOD

NAME	PROJECT POSITION	HOURS EXPENDED THIS REPORT PERIOD
W. N. Rosenberg	Project Supervisor	29
J. G. Thomas	Metallurgist	60*
W. B. Devine	Director of Publications	27
	Total	116

* The major portion of this effort during this period was expended to obtain data for inclusion in the Fifth Quarterly Progress Report.

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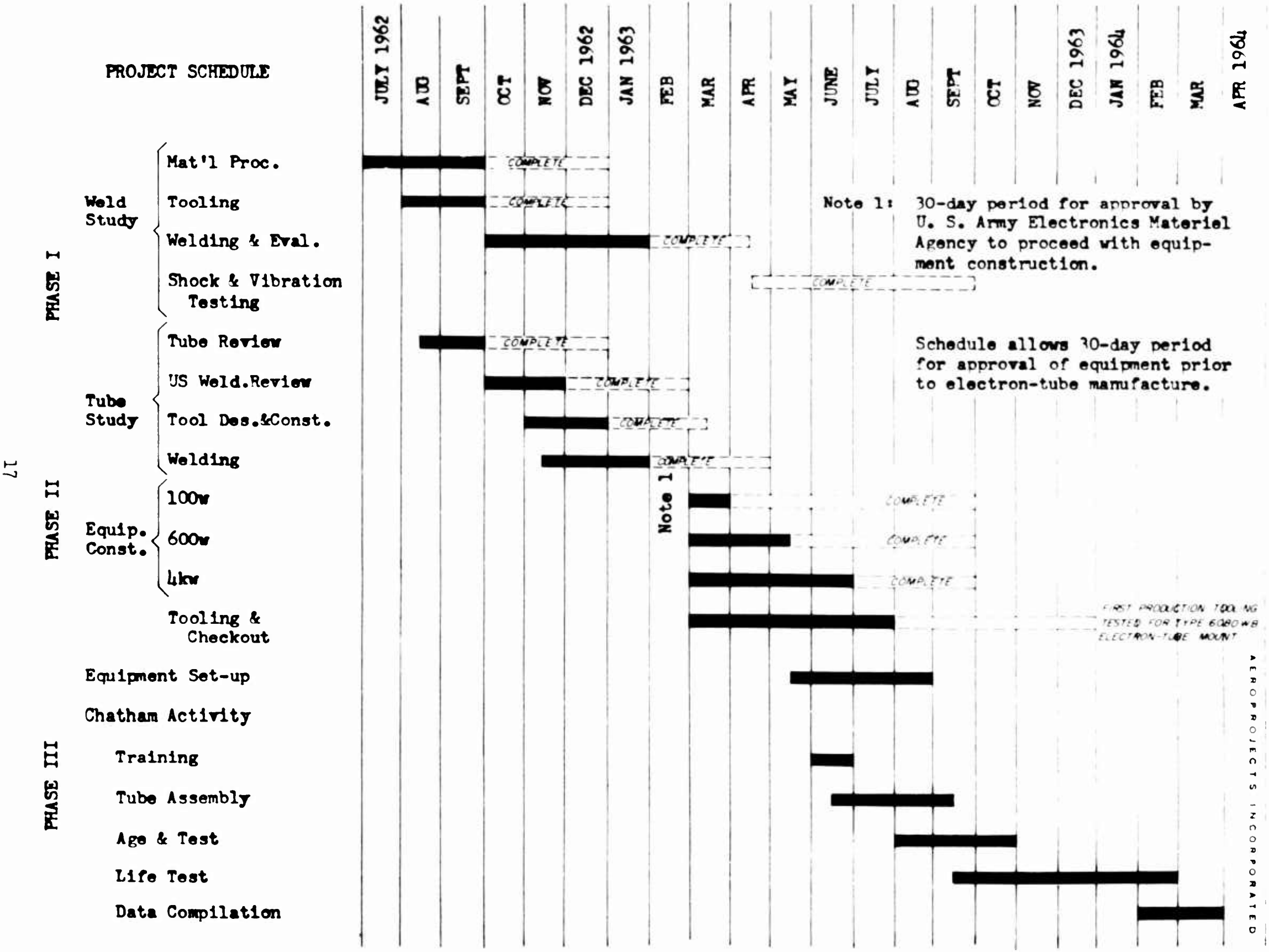

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